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Name of the AI-HUB associated research group: Neuromorphs - The group of Neuromorphic System at Seville Microelectronics Institute (http://www2.imse-cnm.csic.es/neuromorphs/)

Location of the center where the grant will be awarded: Instituto de Microelectrónica de Sevilla (www.imse-cnm.csic.es) is a mixed-center belonging to the University of Seville (www.us.es) and the Spanish Research Council (www.csic.es), is located at the Cartuja Science and Technology Park (www.pctcartuja.es) in the city of Sevilla.

Project Title: Ultra low-power AI for RF control and energy harvesting of neural implants.

Project Description: Therapies for neurological pathologies have been strongly focused on pharmacological treatments. These pathologies range from phantom limb pain, peripheral nerve injuries to alterations of the central nervous system, such as epileptic seizures or psychiatric disorders -depression, anxiety or psychotic disorders-, or the treatment of neurodegenerative diseases such as Alzheimer's or Parkinson's disease. This is changing due to the possibility of improving the patient's quality of life by using implantable medical systems. Most of the implantable neurological circuits currently on the market are bulky, interconnected by wires, use batteries and have little possibility of modifying stimulation adaptively and in a short reaction time. In the future implants, it is desired to continue to miniaturize their size to the maximum while reducing their power consumption. In addition, the new neural implants are intended to be powered by harvesting. This implies that the silicon area of logic circuits, memory and energy storage must be reduced as much as possible. In addition, communication with the outside should be minimized to reduce the power consumption associated with radiofrequency (RF) communications. The desired implants consist of three main blocks: 1) microelectronic circuits which perform the tasks of: i) intercommunication with the outside, ii) harvesting of the RF signal and storage of the energy collected, iii) control of detection and stimulation of neuronal activity, 2) antenna for communication use and signal harvesting and, 3) processing the information collected by the detection electrodes using ultra-low power neural networks, to: i) reduce the amount of information supplied to the external base and thus reduce the power consumption of the micro-implant and, ii) incorporate efficient artificial intelligence (AI) that allows rapid detection of anomalous activity of the neurons, and act accordingly.

The project of the successful candidate will consist of getting familiar with implementing and training simple neural networks, embedded in the implantable device, that efficiently control the power supply of the implantable by RF harvesting and communicating with the external base via wireless, RF using simple communication protocols. Our group has experience in the design of both on-chip neural networks for epileptic seizure detection and in low-power radio frequency integrated circuits for communications. The project can be adapted to the candidate's preferences and prior training, emphasizing more the computational and algorithmic aspect, or setting the strength onto more hardware specific aspects regarding neural network design and RF circuitry. Schedule and duration of the scholarship are negotiable with the successful candidate in order to adjust them to the candidate's restrictions and preferences during the training at IMSE.